TG LAB
G. QUIRK

INSTRUCTION BOOK

for

MODEL 694 TERMALINE

RADIO FREQUENCY WATTMETER

BIRD

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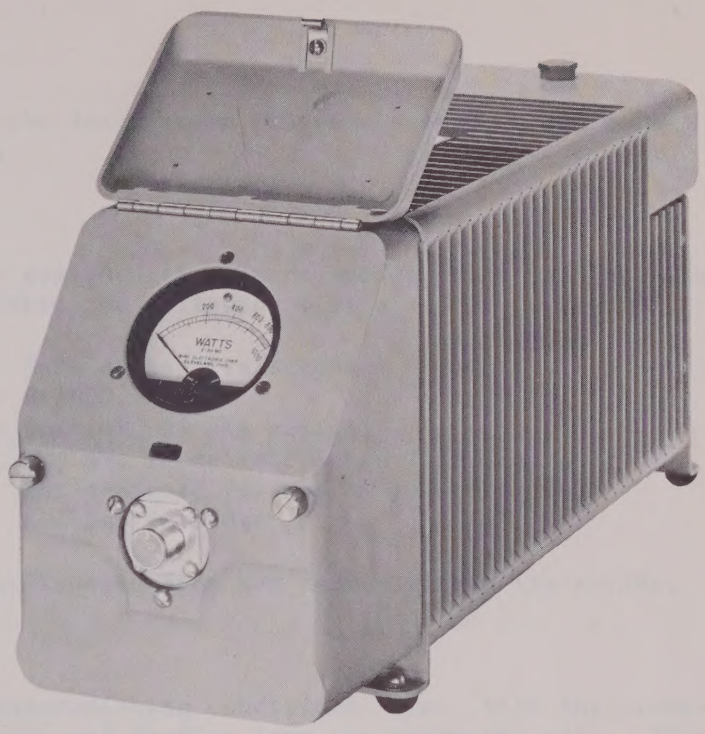
MODEL 694 TERMALINE

RADIO FREQUENCY WATTMETER

TERMALINE RF LOAD
AND WATTMETER
MODEL
694



Model 694
0-1000 Watts, 2-30 mc

DESCRIPTION:

The Model 694 is a direct reading instrument for absorbing and measuring RF power in 50-ohm coaxial line systems through the range of 2-30 mc. This portable instrument is used for field or laboratory testing of transmitters under non-radiating conditions. The Model 694 utilizes the unique Bird RF input receptacle, designed to accept any of the Bird Quick-Change RF Connectors.

FEATURES:

Accurate absorption type wattmeter for low frequency application.
Direct reading to 1000 watts.
Quick-Change input connector - adapters not needed.
Portable - flush type retractable handle.
Non-radiating load with low VSWR.
No outside power source required.
Air-cooled load.

SPECIFICATIONS:

Frequency:	2-30 mc
Power:	0-1000 watts
Input Connector:	Bird Quick-Change Connector Type Female "N" normally supplied, most common coaxial connectors available
VSWR of Load:	Less than 1.1 to 1 in specified range
Impedance:	50 ohms nominal
Size:	20-1/2" lg. x 5-15/16" w. x 8-3/4" h.
Weight:	31 lbs.
Cooling Method:	Air Convection

MODEL 694 TERMALINE WATTMETER

I GENERAL DESCRIPTION

1. SCOPE OF MANUAL

This instruction book covers the description, theory, operation and maintenance of RF Wattmeter Model 694.

2. PURPOSE OF EQUIPMENT

a. RF Wattmeter Model 694 is designed to measure output power and facilitate tuning of transmitters falling within the following limits:

Frequency	2-30 megacycles/second
Power	0-1000 watts
Input Circuit	Coaxial, 50 ohm nominal
Type of Modulation	CW, AM, FM or Television Type Signals. Not designed for use on pulsed power similar to radar.

b. It can be used to measure RF power from any source within its rating.

3. DESCRIPTION

a. Power is measured under non-radiating conditions, i.e., with the transmitter disconnected from its antenna and feeding into the wattmeter only. This is an absorption wattmeter as distinguished from the other general class of "transmitted power" or "thru" wattmeters.

b. The wattmeter is built around an accurate coaxial resistor which is the transmitter load element. This resistor terminates 50 ohm lines such that the voltage standing wave ratio remains below 1.1 up to 30 mc. The transmitter, when loaded by the wattmeter, then operates into a known resistance of the value for which it was designed, and to a degree not often realized with antennas, particularly broad-band types.

c. Power input to the resistor is measured by means of a crystal voltmeter arrangement, the d-c meter of the voltmeter reading directly in rf watts.

d. This instrument is direct-reading. No reference to calibration charts is needed in normal use.

e. The Model 694 is specially designed for an arrangement of Bird type quick-change "QC" input connector. These connectors are of the standard AN Types, the unit being normally supplied with a Female N Type input. Other standard AN type "QC" connectors, as listed on page 7 of this manual, may be procured on special order. These connectors may be readily interchanged with a screwdriver, see Maintenance Section.

f. Overall dimensions are 20-1/2 in. long x 6 in. wide x 8-3/4 in. high. Net weight of equipment is 31 pounds.

4. SPECIFIC USES

Measurements from the RF Wattmeter Model 694 may be useful for the following purpose, among other:

a. Checking installation of transmitter.
b. Routine and trouble-shooting maintenance.
c. Production and acceptance tests.
d. Transmitting tests.
e. Loss measurements on transmission lines.
f. Testing of coaxial line insertion devices, such as connectors, switches, relays, filters, tuning stubs, patch cords, etc.
g. As an accurate rf resistance, substantially independent of frequency and line length.

II THEORY OF OPERATION

1. INTRODUCTION

There is very little lumped-constant, conventional circuitry in this instrument. Circuit elements are of the distributed constant type, machined and fabricated, as in microwave components.

2. CRYSTAL VOLTAGE LEVEL

The crystal operates at 1.2 volts and 100 microamps, rectified d-c, for full scale deflection. This value is conservative with respect to overload damage. It has been determined that four times full scale power can be applied momentarily without appreciable change in crystal characteristics or calibration. Since the crystal voltmeter is connected across the load resistor, substantial power is required for voltage overload.

3. CRYSTAL STABILITY RELIABILITY

a. ADVANTAGES - The silicon crystal rectifier used is comparable and in some respects superior to electron tube diodes. Some of their advantages are: Smaller size, no filament supply, and no zero shift with time or change in line voltage.

b. STABILITY - The application of crystal diodes in calibrated direct-reading voltage or power measuring instruments is relatively new. Most people are familiar with crystal diodes in different applications, such as detectors in receivers. The stability realized may prove surprising to those who have not had the opportunity to use modern crystals with good standards of rf measurement. From a long program of measurements in the laboratory and from field experience with many similar instruments in industrial use, it has been found that calibration will hold as well as in electron tube voltmeters. There is no indication of long time aging and calibration may be expected to hold within 2% for variations chargeable to the crystals.

4. COOLING SYSTEM

a. HEAT TRANSMISSION - To assure full power rating, the cylindrical film resistor is immersed in coolant which carries heat by convection to the inside wall of the enclosing cylinder thru openings in the coaxial metal shell. From there heat is conducted thru the fins and carried away by air convection. It will handle rated power (1000 watts) without damage at an ambient temperature of 40° Centigrade.

b. ELECTRICAL SIGNIFICANCE OF COOLANT - The unit must be reasonably full of proper coolant (Monsanto OS-59, approx 1.1 gallon) or the rf input impedance and calibration will be changed. The dielectric constant of the coolant is an important factor in determining the input impedance. Careful attention has been given to obtaining a design which is leak proof under service conditions. In order to get both high quality rf connectors and a leak proof design, teflon insulators compressed as gaskets for the rf connections and "O" rings of synthetic high temperature resistant rubber are used.

WARNING

NO PARTS IN THE VOLTMETER MAY BE REPLACED WITHOUT AFFECTING THE CALIBRATION.

III INSTALLATION

1. PORTABILITY

The RF Wattmeter Model 694 is essentially a portable test equipment instrument. It should be placed as close as possible to the point at which the power output reading is desired. Retractible handle is placed in center of top face of radiator for ease of carrying the unit.

2. OPTIONAL FIXED MOUNTING

a. The wattmeter may be fastened to an operating table, test bench, etc. For this purpose, the four rubber bumpers held on by acorn nuts may be unscrewed from the flanged feet at the bottom of the radiator, and the four 9/32 diam. holes used to mount the wattmeter. Use standard 1/4-inch hardware.

b. If the wattmeter is to be mounted on rigid benches, etc. which are not shock mounted, use shock mounts under the wattmeter to replace the shock protection afforded by the rubber feet. The central bushings of suitable small shock mounts may be attached with 1/4-20 machine bolts thru the holes in the radiator feet, and the flanges of the mounts screwed to the mounting surface or to an auxiliary metal plate.

3. LOCATION

a. Free circulation of air around the wattmeter is necessary if operated above 300 watts for more than a few minutes. Keep it reasonably in the clear, and avoid mounting it on, or alongside of, heated surfaces.

b. Operate only in the normal position, feet resting on a horizontal surface. Try to allow at least 4" clearance on all sides. Space above wattmeter should be kept as clear as possible for good air cooling.

IV OPERATION

1. TO MEASURE TRANSMITTER POWER

a. Locate the wattmeter where a short patch cord, preferably not over 5 ft. long, will connect the transmitter to the wattmeter and where the meter is conveniently readable while adjusting the transmitter.

b. With the TRANSMITTER OFF, disconnect the antenna line and connect the wattmeter.

c. For this use a patch cord of 50-ohm cable, such as RG-8/U or RG-9/U and a Type N plug, such as the UG-21D/U series.

d. Turn the TRANSMITTER ON. The wattmeter will directly indicate the power being absorbed.

e. If the adjustment of the transmitter is necessary, follow the pertinent instruction book. OBSERVE SAFETY PRECAUTIONS about high voltages in the transmitter. The wattmeter indicates results in watts of direct tuning into the standardized termination of 50 ohms afforded by the wattmeter.

f. When desired output has been obtained, NOTE THE READINGS of the wattmeter, and of the meters provided on the transmitter, particularly of the plate current and voltage meters on the final stage, and of antenna line monitor. These readings bear a direct relationship to power output, and are useful in relating the transmitter output to its antenna, to its output into the wattmeter.

g. TURN TRANSMITTER OFF before opening RF connections to the wattmeter.

h. RECONNECT THE ANTENNA LINE, TURN TRANSMITTER ON and note its meter readings. If the antenna impedance (VSWR) is correct, the transmitter meters will read as they did with wattmeter connected. Some allowances should be made for the fact that VSWR's around 2 to 1 are normal at some frequencies in the range of good broad-band antennas.

i. In case of significant difference between transmitter meter readings on wattmeter and antenna, RETUNE THE FINAL TANK AND ANTENNA COUPLING, using plate dip method or antenna monitor readings as specified in instruction book for the transmitter

j. REPEAT THE ENTIRE PROCESS FOR EACH NECESSARY FREQUENCY.

V MAINTENANCE

1. INTRODUCTION

a. The circuit simplicity and essentially mechanical design of the wattmeter result in a minimum of maintenance, since all electrical circuits are sealed and rigidly mounted.

b. Generally, the unit will require only the routine wiping and cleaning coupled with reasonable care in handling.

c. Preventive and corrective maintenance are grouped together in this section.

2. GENERAL MAINTENANCE

a. Dust off the unit when necessary, removing any deposit of dirt or grime. Especially important - keep the jacks and plugs clean.

b. Keep the plug on the meter cable firmly in place on the dc jack at the side of the voltmeter block. This excludes dirt and moisture. If this connector has been "stationary" for a long time, slightly loosen (unscrew) the knurled nut on the plug, rotate its right angled sleeve back and forth a few times to clean the contacts, then retighten securely.

c. Protect the power input jack by keeping it plugged or covered when not in use. If the connector parts become dirty, clean carefully. Use a cotton swab stick dipped in Inhibisol* or equivalent, trichlorethylene, or other dry solvent. CAUTION - AVOID BREATHING FUMES when using any noxious cleaning agents. Give special attention to cleaning the exposed faces of the insulators (teflon) and also to all of the coaxial surfaces.

d. Dropping is the most likely source of damage to the wattmeter. DO NOT DROP IT. The microammeter movement or voltmeter parts might be damaged. Close the meter flap when not in use, particularly when carrying the wattmeter.

3. REPAIRS AND REPLACEMENT

Note: The rugged and self-contained nature of this equipment should ensure very little maintenance due to parts failure. If difficulty should occur, particularly in electrical functioning, it is generally advisable to return the unit to the factory for repair and re-calibration. Specified accuracy of the unit is then assured, and the qualifications of a new instrument are maintained. Following below are the significant electrical components of the Model 694, which may be services as described:

a. The Resistor-Voltmeter Unit - R.F. Section, Bird part #694003.

1. This is an integral component, not subject to further disassembly by field maintenance. The condition of the load resistor proper may be checked by means of its dc resistance. An accurate resistance bridge, good to 1% or better at 50 ohms, is required. Using low resistance leads (preferably a short length RG-8A/U cable with a UG-21D/U plug) attached to the Female N Type input

* Inhibisol - A non-toxic, non-flammable dry cleaning agent, manufactured by the Penetone Co., Tenafly, New Jersey.

jack, measure the load resistance. A change of more than 2 ohms from the value of the resistance stamped on the nameplate will cause wattmeter readings beyond tolerance.

2. To remove the RF Section from the wattmeter, loosen the two slotted drum head screws at the front of the meter case just below the corners of the lid. Unscrew these fasteners until they are free of studs behind, which project from radiator face. Pull out meter box sufficient to expose the voltmeter block at the side of the nosepiece. Unscrew the knurled nut from the jack on the voltmeter block to disconnect the meter cable. Pull the meter cable out. Take the meter box assembly off entirely.

3. Stand the wattmeter vertically, with the nose up, and support the radiator so that it is properly stable. Unscrew the #10-32 clamping screw on the V-band clamp on the top face of the radiator. Remove the V-band and pull the resistor-voltmeter unit (RF Section) straight up and out from the radiator tank. Allow sufficient time for coolant drainage before removing the unit from face of tank. Replace RF Section if required.

4. Whenever possible, use new external seal O-Ring part #81139 when re-attaching any RF Section. It should be noted that even within allowed dc tolerance of the load resistor, a change in this resistance will produce a corresponding apparent change in the wattmeter reading. Be sure that there is enough dielectric coolant (Monsanto OS-59 Hydraulic Fluid - Bird part #5267) to come almost to the lip of the tank when the rf section is positioned.

5. To reassemble, reverse procedure in above paragraphs. The oil seal (O-Ring #81139) for RF Section should be completely clean, correctly placed - against the beveled flange all around and without twists. Tighten the clamp band securely, and then place the unit horizontally. After a short time, check carefully for possible oil leakage. When attaching the meter case, be sure that the Extension Sleeves #24377 are placed on the inside over each of the Meter Housing Screws #276017.

b. Microammeter (Meter Assy - Bird part #276021)

1. As previously stated, substitution of the microammeter without wattmeter recalibration may produce errors (possible up to 4%, but ordinarily perhaps 2% of full scale).

2. These meters can be checked for accuracy. However, this should be attempted only by one familiar with procedures for testing sensitive dc microammeters - they may be readily damaged. USE CARE. Test the meter as a microammeter in series with a low voltage battery, variable resistor and an external microammeter. Full scale current should be 100 microamperes ± 2%.

3. To replace microammeter proceed as in sub-par. a.2) above: Raise the cover on the meter case and remove the three flat screw and nut assemblies which fasten the meter to the inside of its case. Remove Meter Assy. #276021-2 and replace. Reverse foregoing to install new meter.

4. When attaching dc plug to voltmeter jack, be sure contacts are essentially clean and wipe the plug as described in par. 2b above.

c. Other portions of the equipment might be replaced for purely mechanical reasons. Handling this should be relatively easy for anyone accustomed mechanical assemblies. The important items follow hereunder:

1. Rear cover and seal on radiator tank. Before loosening rear end (if the coolant is not drained from the tank) the radiator should be stood on end with nose pointed down. Unscrew the four #10-32 truss head screws at the corners of the Guard, Cover #24378 and remove guard box. Unscrew the Tube Nut from the tank nozzle and pull free. Unscrew clamp screw from bottom of V-band (same type as at front) and remove V-band clamp. This releases the rear Cover #24388 (which includes attached escape tube with captive nut) and the diaphragm Seal #24389.

2. The expansion tank is vented through the Relief Valve #24381 screwed into the top. This is a ball and spring type pressure relief valve which maintains its seal below the escape pressure. The unit unscrews from the socket, but is not itself subject to disassembly. The seat is sealed by the compressed O-Ring #5131, which should be included when replacing the vent valve.

3. Radiator Handle. With the meter case removed, the radiator handle may be replaced by use of a suitable screwdriver. Remove the #10-32 truss head retaining screws at the end of line of holes thru top center of the front fins. Push handle forward and pull up.

4. CONNECTORS - QC

The input connector of the Model 694 may be readily changed to other AN Standard Types. Alternate available types are listed below, and may be procured from Bird Electronic Corp. To change connectors, simply unscrew the four #8-32 round head screws on the square base flange, and pull connector straight out. To attach connector, reverse procedure, being certain to properly engage center pin in contact hole, keeping alignment true; fasten flange securely.

Available Quick-Change Connector Types - with Bird part number:

Female N	424062	Female LC	424031	Female C	424100
Male N	424063	Male LC	424025	Male C	424110
Female HN	424073	Female LT	424018	Female UHF (SO-239)	424050
Male HN	424049	Male LT	424012	Male UHF (PL-259)	424179
		7/8" EIA - Airline	424002		

Bird Electronic Corporation
Cleveland 39
Ohio

5. REPLACEABLE PARTS LIST

Name	Part Number
RF Section	694003
Meter Housing Assy	694002
Screw Meter Housing	276017
Meter Assy	276021-2
Extension Sleeve	24377
Guard, Diaph. Cover	24378
Cover Assy, Diaph.	24388
Seal, Diaph.	24389
Clamping Band	24343
O-Ring, RF Sect.	81139
Coolant OS-59 (1.1 gallon)	5267
O-Ring, Vent Valve	5131
Valve, Vent	24381
Radiator	24391
Radiator Sub-Assy	24390
Handle	24328
Bumper Foot	5049
Nut, Acorn	811171

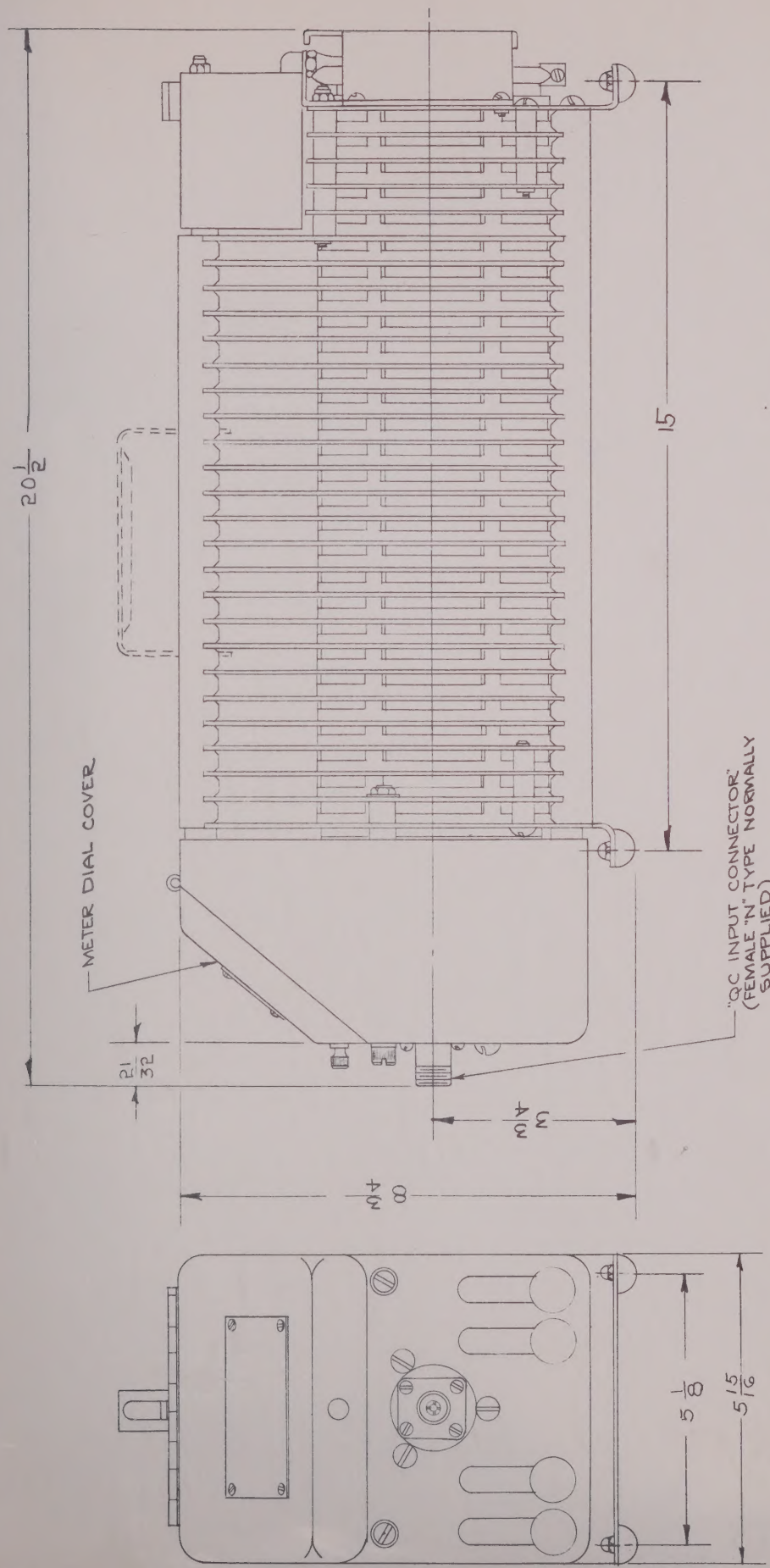
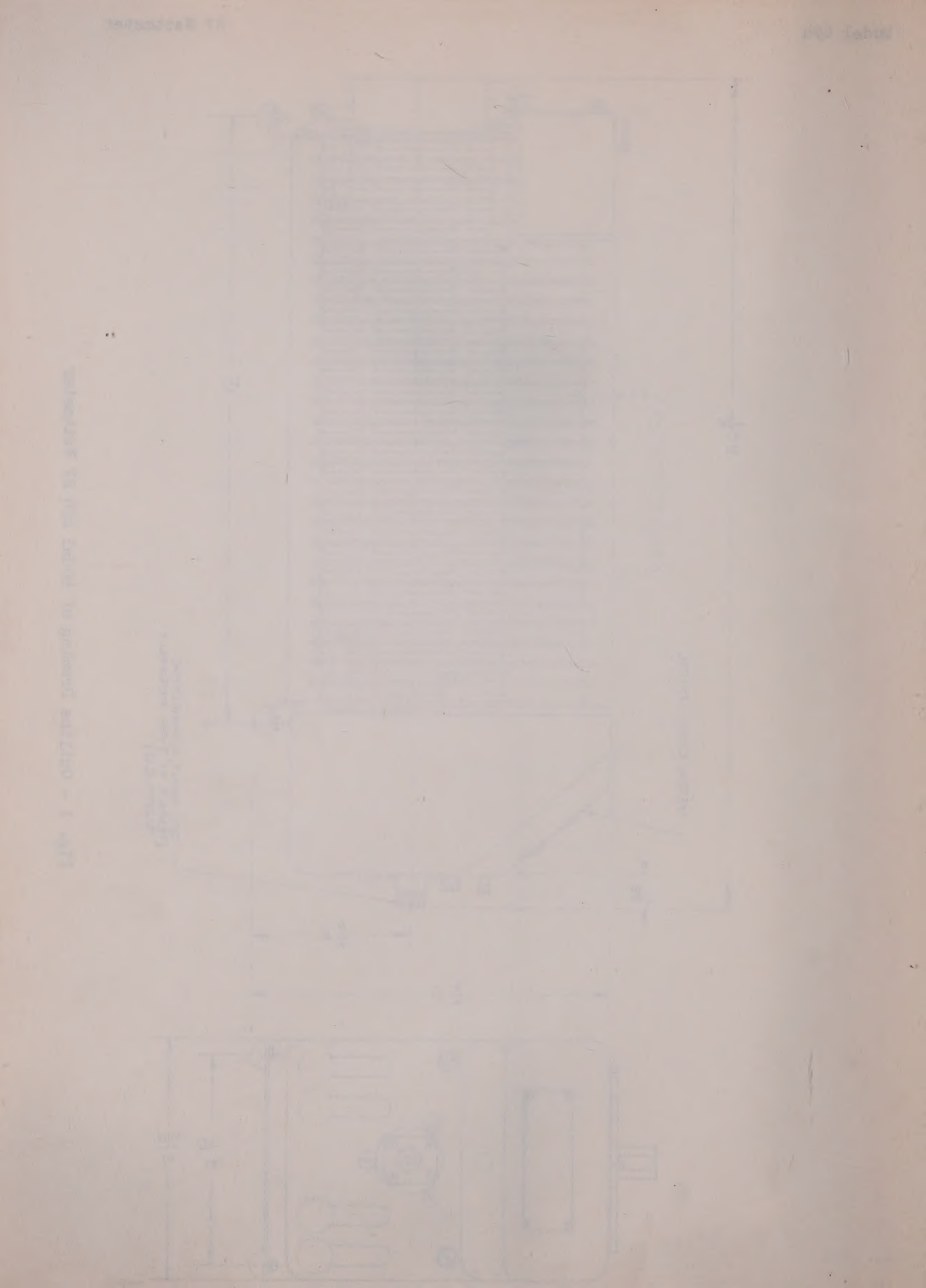
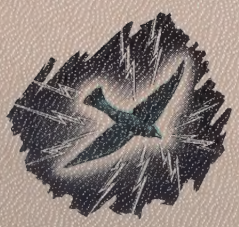


Fig. 1 - Outline Drawing of Model 694 RF Wattmeter





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